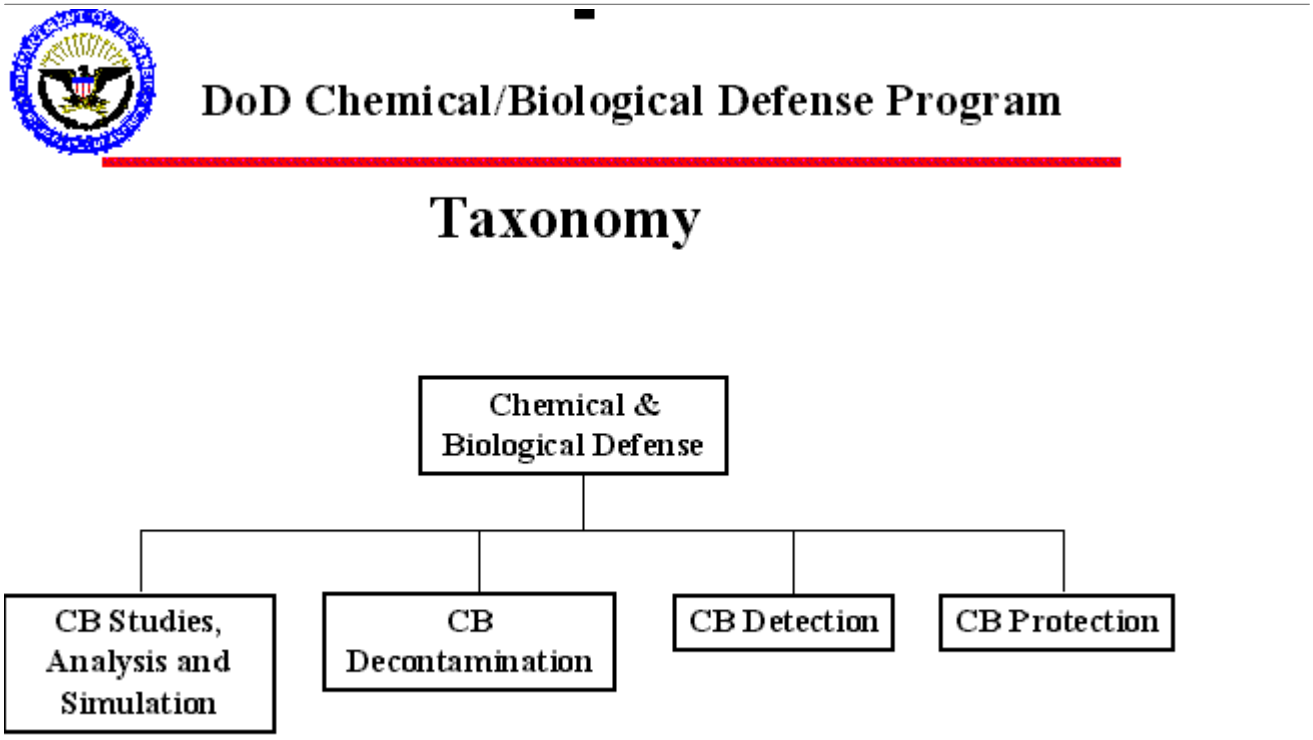
1996 CB&N Defense TARA

TARA Team Members

Dr. Ted Prociv, Chairman
Dr. Bob Beaudet
Mr Matt Hutton
Dr. Ed Poziomek
Dr. Gary Resnick
Dr. Sal Bosco, Executive Secretary



CB Technology Area

The CB Technology area invests in science and technology to provide improved capabilities to enable our forces to sustain operations with minimal adverse impact in a chemical or biological environment. These capabilities include avoidance of contamination by detecting C or B agent use as early as possible; providing situational awareness of the nature and extent of CB contamination; providing individual or collective protection against exposure to agent; and decontamination and dewarning to restore operational tempo.

1995 TARA
CBD Program Issues

- Integration of counterproliferation support programs
- Integrate medical and non-medical S&T programs

- Outselect redundant efforts
- Improve exploitation of NDI, COTS, and IR&D
- Improve integration of ARPA, DNA, National Labs, Industry and OGA efforts
- Coordination of modeling efforts
- Formalize TPCBD/Project Reliance under JSMG
- Change TAR/TAA/TAP schedule to conduct TAR in January/February in order to support POM builds

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1995 TARA

- Modeling
    - PAT
        - Requirements process for models
        - Prioritization
        - VV&A
        - Consolidate/Outselect models
    - Data availability
- Decontamination
    - Requirement and feasibility of wide area decontamination
    - Joint Service Master Plan needed before any further work.
        - Determine requirements, if any, for wide area decon
        - Examine logistics support to a dirty environment
        - Consider de-warning as high priority; coordinate with detection (Get the forces out of MOPP.)
    - Examine decon in global projection scenario

- Detection
    - Standoff vs. Remotely-deployed point detection approaches need to be evaluated
    - Integration of systems into digital battlefield/C2 networks
    - Need to resolve toxicity levels from Reutter-Wade report
    - Need for comprehensive biodetection architecture for CB defense to focus S&T
- Individual Protection
    - Need for oronasal expedient mask (NDI?)
- Collective Protection
    - Need to select best filtration approach
    - Need for self-decontaminating filter
    - Need to make progress on monitor imbedded in filter to extend filter life

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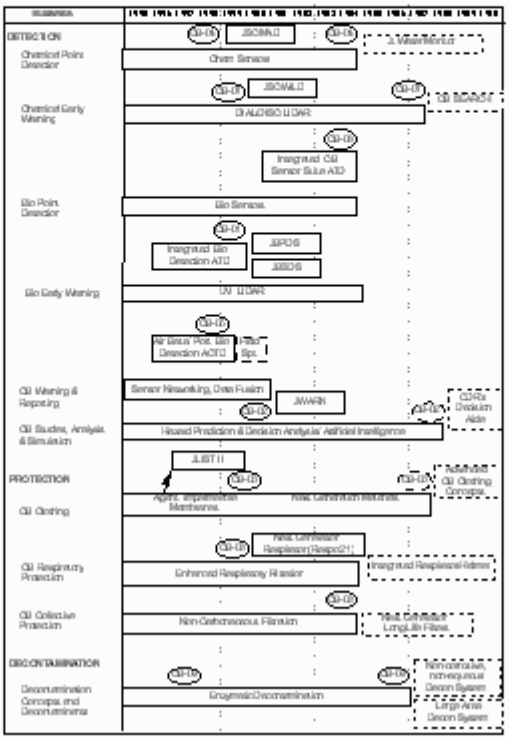
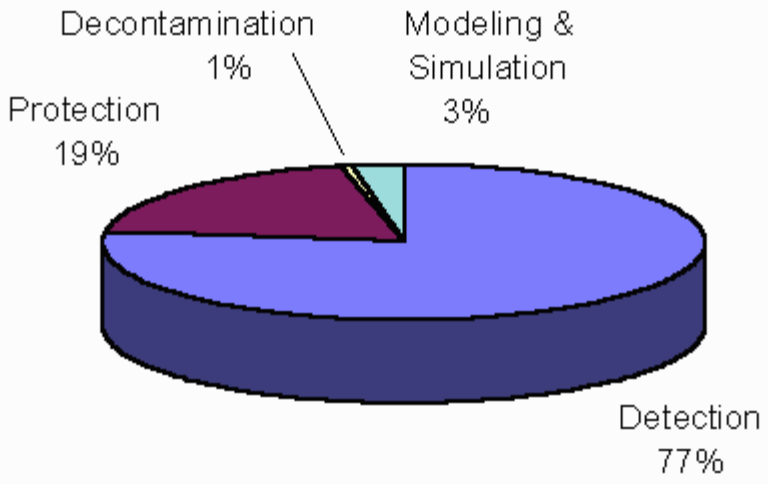
DoD Chemical/Biological Defense Program

CB Roadmap



DoD Chemical/Biological Defense Program

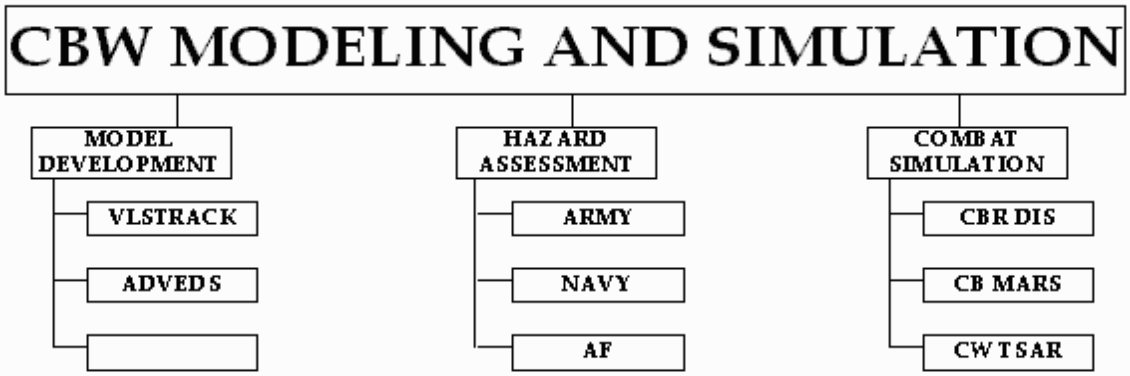
FY96 CB Defense Tech Base Funding



CBD ANALYSIS, SIMULATION AND ASSESSMENT

Modeling

1996 CBW Defense TARA Briefing for DDR&E



22 APRIL 1996

OLD TPCBD M&S SUBPANEL:
ROGER L. GIBBS (NSWCDD)
MILES MILLER (ERDEC)
DR. CLYDE REPLOGLE (WPAFB)

Definition, Scope, and Goals

- **DEFINITION**
  User friendly, standardized, verified, validated, and documented software for standalone or imbedded use by operational forces, combat planners, analysts, trainers and the R&D community
- **SCOPE**
  Development of the software tools and their application to conduct hazard/casualty assessments, determine defensive requirements, support combat simulation and provide operational guidance
- **GOALS/ RATIONALE FOR INVESTMENT**
  Satisfy DoD's requirement to conduct real time operational hazard assessment of CBW attacks, intelligently and realistically analyze requirements for CB defense equipment and establish the appropriate doctrine, and include the effects of CBW attacks in all levels of campaign analysis

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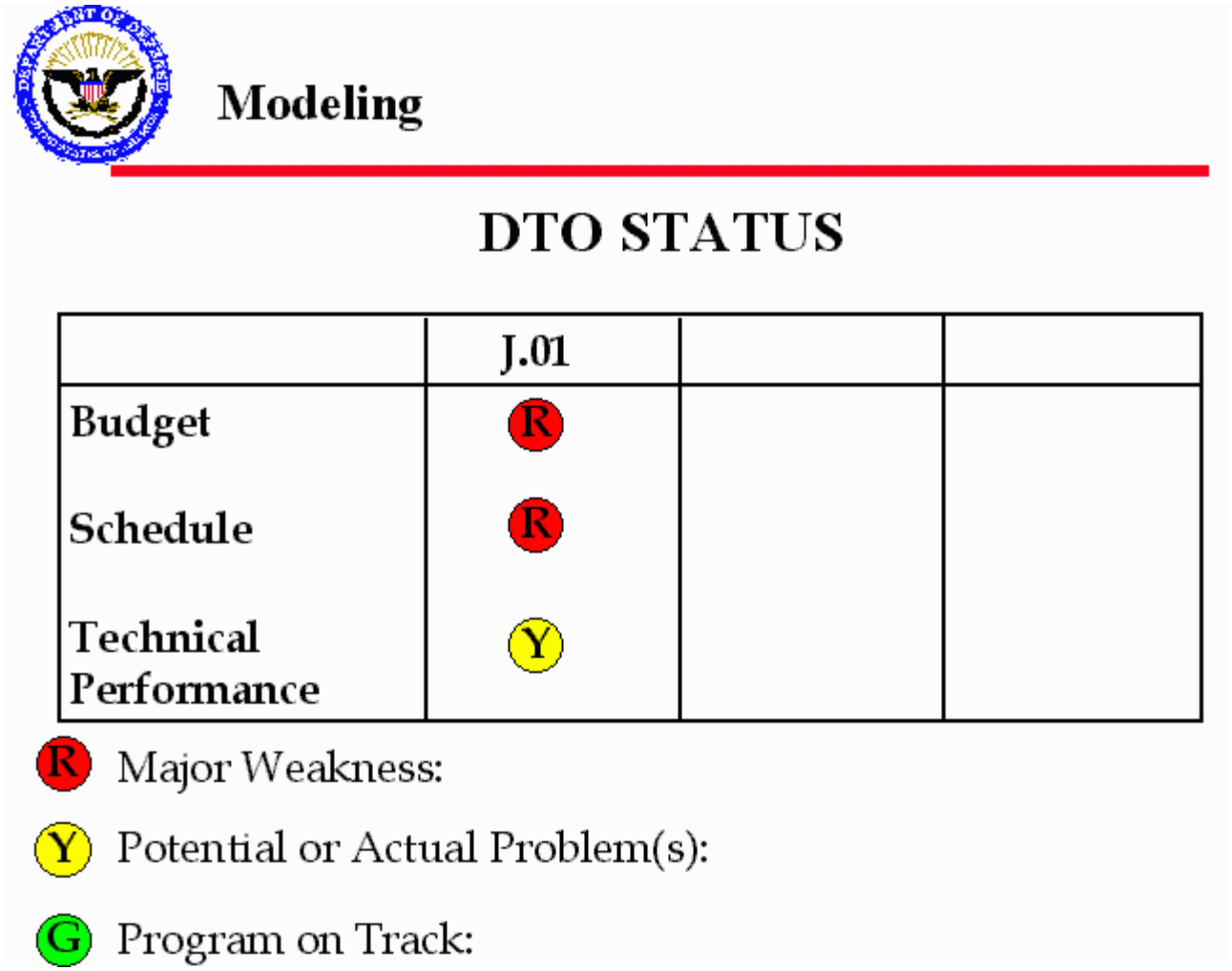


Accomplishments

- Delivered versions 1.6 and 2.1 of VLSTRACK
- Support to Global 95 Exercise
- DIS facility CB simulation capability
- 3D Navy CB model for flow around structures delivered

Strengths and Weaknesses

- **Strengths**
  - Modeling PAT participation
  - Increased user awareness and acceptance of CB issues in exercises
- **Weaknesses**
  - Funding inconsistancy
  - Program fragmentation between services and DNA
    - Confusion between operational models and technical models
    - Area is not a CB commodity area for JSIG/JSMG

Issues and Recommendations

- ISSUE 1 Program fragmentation
  - RECOMMENDATION
    - Formation of the JSIG/JSMG commodity area for operational models
    - Fold Agencies into operational model
    - Implement Modeling PAT recommendations
    - treat engineering models as enabling technologies
- ISSUE 2 Inconsistent funding
  - RECOMMENDATION
    - Fix POM submission

BUDGET and SCHEDULE

REASON: Loss Army and delay of Air Force M&S funding for FY96 has delayed progress on the CB DIS and to AF upgrades to the CW TSAR airbase model. CW TSAR was also a candidate for possible modifications to simulate port operations.

ACTION PLAN: Delay Army CB DIS effort and AF CW TSAR effort until funding becomes available. Reassign affected personnel to other projects.

TECHNICAL PERFORMANCE

REASON: Delay in Army CB DIS effort will delay subsequent adaptation and use by Navy for MARS.

ACTION PLAN: Navy will integrate existing CB DIS and attempt to upgrade when Army completes development.

PAT CHARTER

- Evaluate current modeling efforts
- Provide OSD with a consolidated and integrated modeling program
- Harmonize Service and Agency CB modeling
  - create joint programs
  - eliminate overlap and duplication
- Examine VVA requirements

Requirements Subgroup

- Identify Operational Requirements
  - Design Requirements Generation Process
  - Identify current #1 priority need
- Recommend Requirements Priorities
  - Identify Priority Needs
  - Design Priority Setting Procedure for JSIG
- Recommend a Process to:
  - Verify requirements
  - Assess model development against requirements
  - Identify and resolve duplication

Modeling Subgroup

- Identify/classify CB modeling organizations and models
- Catalog data sets
- Report on VVA procedures and requirements
- Evaluate need for standardization between models
- Institutionalize model subgroup under JSMG
- Other:
    - Establish a Joint NBC Models and Simulation Coordination Group under the JSMG
    - Develop an M&S Master Plan
    - Add radiological modeling to CB family

DEFENSE TECHNOLOGY OBJECTIVES

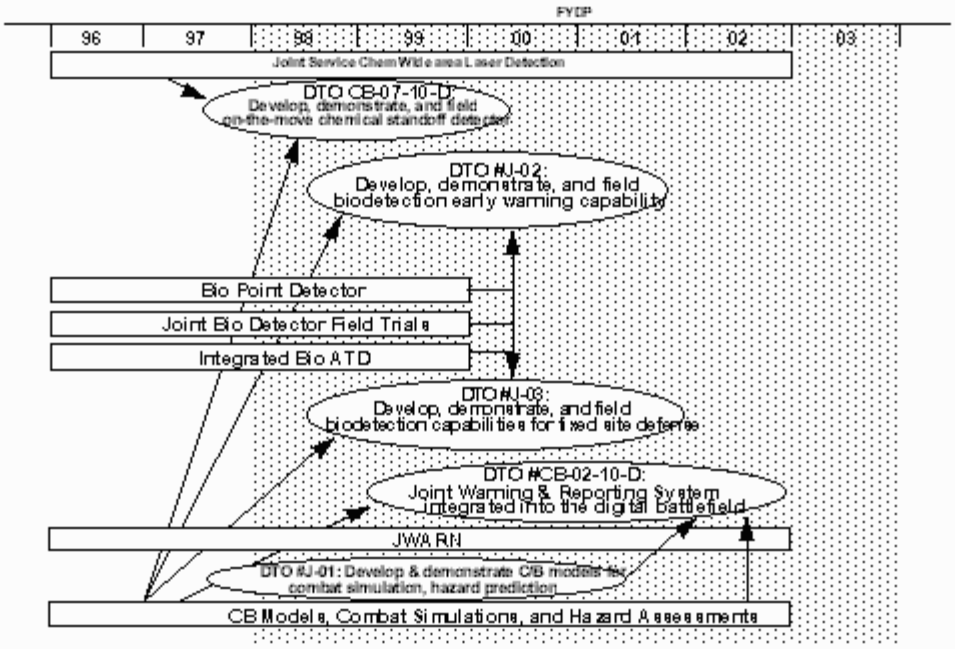
J.01. CB Modeling. By FY96, develop, verify, validate, and document a hazard model for operation use. This same model will also be the basis for systems which support TBMD COEAS, BW detector studies, training, etc. By FY97, demonstrate the ability to evaluate the operational performance of representative Stand-Off CB detector systems using the Distributed Interactive Simulation (DIS). By FY99 standardize a CFD model for detailed analysis of ships, combat vehicles, shelters, etc. By FY02, complete algorithms for inclusion in the JCS JWARS model for joint tactical and strategic campaign analyses. These accomplishments will result in a standardized and documented DIS compliant joint capability for the full range of CBW hazard analyses for materiel development, combat development, training, test and evaluation, COEA's, and operational requirements.

Supports: Laser Stand-Off CB detectors, lightweight stand-off chemical detector, NBC Reconnaissance Vehicle, Shipboard Advanced Liquid Agent Detector (SALAD), JSLIST, Armored Systems Modernization, LAM Exercises, Battlefield Distributed Simulation-Development (BDS-D) ATD, Combined Arms Tactical Trainer ATD, Integrated Bio ATD, JWARN, JWARS, JPO-BD Air Base/Port Bio Detection Network ACTD, Maneuver Control System (MCS), and the Tactical Environmental Support System (TESS).

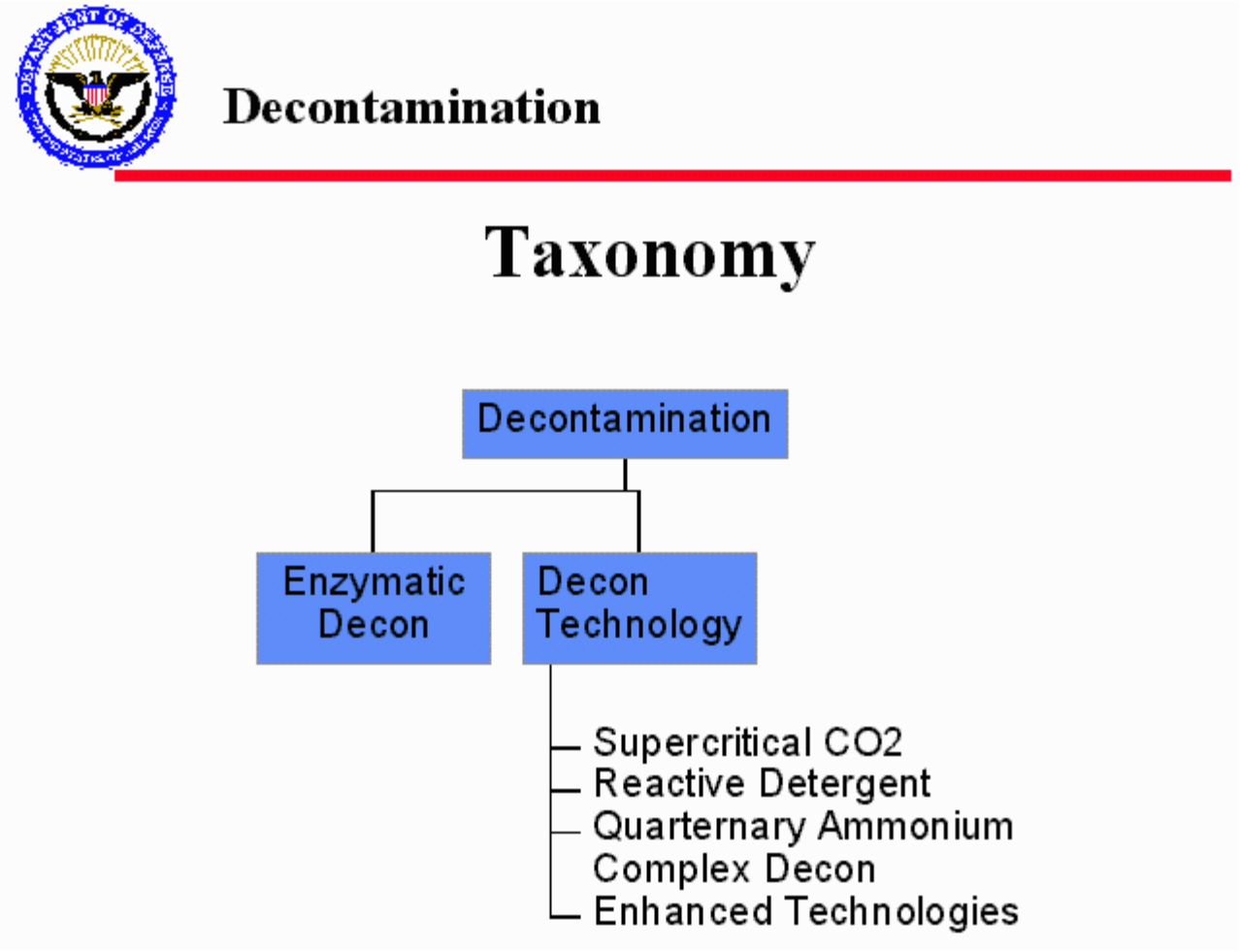
Modeling

Joint Warfighter Science and Technology Plan

Figure IV.J.7. Roadmap - Chemical/Biological Agent Detection



Decontamination



Definition and Scope

- **Definition:** Systems to remove and neutralize CB agents
- **Scope**: Decontamination systems for personnel, individual equipment, tactical combat vehicles/equipment, sensitive equipment, interior and exterior areas of aircraft, ships, and wide areas at fixed sites.

Goals and Rationale for Investment

- **Goals:** Provide systems which are non-corrosive, non-toxic, and environmentally safe, suitable for timely clean up of CB agents on all materials and surfaces.
- **Rationale for Investment:** Systems will enable forces to reconstitute personnel and equipment rapidly, increase efficiency and lessen logistic burden.

Decontamination

DTO Status

	DTO CB-09-12-D
BUDGET	G
SCHEDULE	G
TECHNICAL PERFORMANCE	G

Accomplishments

- Completed the sequencing of the gene for a bacterial G-agent degrading enzyme. Determined the natural function of the enzyme (dipeptidase).
- Successfully demonstrated freeze-drying of recombinant enzyme. No loss of activity after storage for a year at 37 degrees C.
- Demonstrated the ability of the enzyme to be incorporated into a foam and maintain significant levels of activity. Potential for dual-use systems.

Strengths and Weaknesses

Technical/Programmatic

- Program currently overbalanced towards DS2 replacement.
- Now developing a program to respond to power projection requirements. (Sea, airport decontamination.)

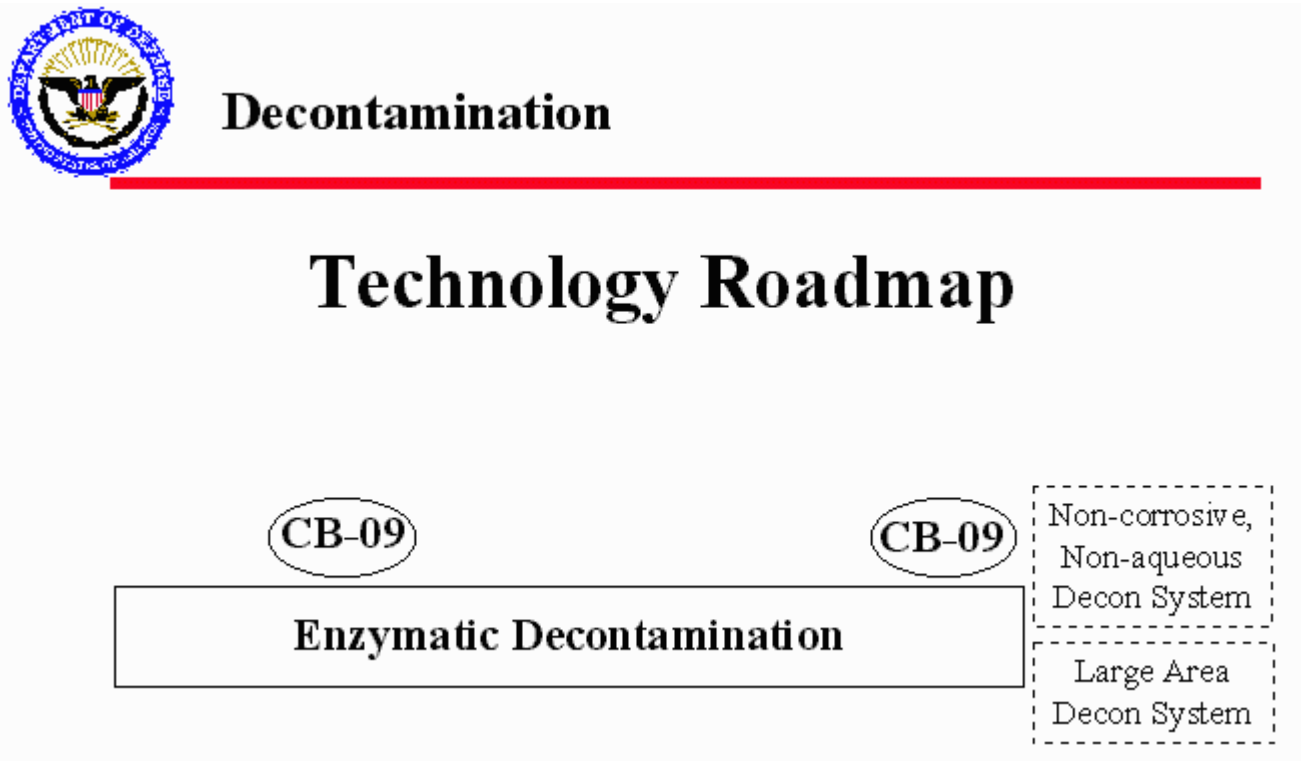
Issues

- Issue 1
  - How to manage the growth of this area power projection. Now a CINC concern.

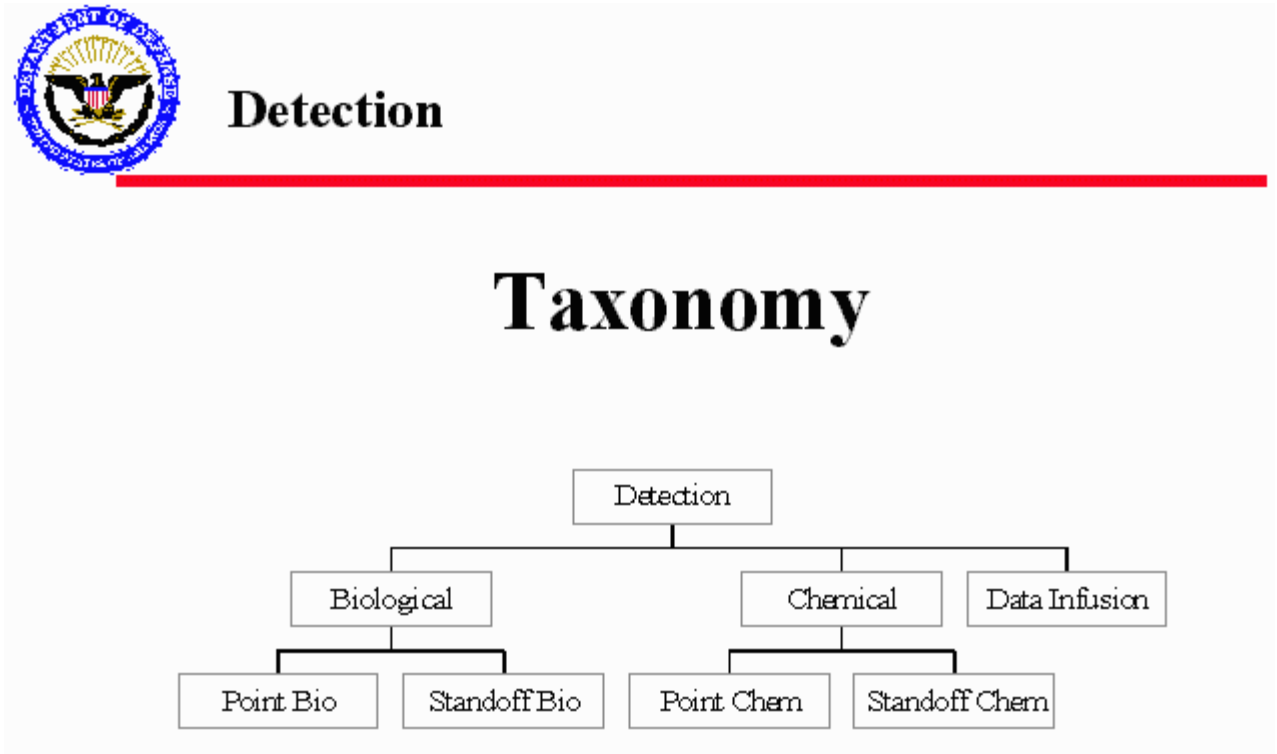
- Recommendation
  - Define the problem in the coming year. Include heavy transport (air, sea) issue.
- Issue 2
  - Non-aqueous decontamination medium logistics sensitive electrons
- Recommendation
  - Exploit NDI/COTs/academia for solutions.

DTO CB-09-12-D
Decontamination for Global Reach

- By FY97, determine the feasibility for large area decontamination and evaluate the need for decontamination of any validated chemical and biological threat agents at fixed sites, such as airfields, naval bases and depots, as well as civilian areas.
- By the end of FY02, demonstrate the efficacy of enzymatic decontamination system for G and V-type nerve agents in foam based dispersion systems.
- By the end of FY03, identify a system that can be utilized to decontaminate Mustard (HD) and biological warfare agents.
- In FY04-05, incorporate the HD and biological warfare agent system into the foam matrix with enzymes identified for G and V-type agents. Develop, characterize and optimize the system for efficiency.
- During FY06, demonstrate the efficacy of the multi-agent decontami-nation system against a spectrum of CB agents.



Chemical Biological Detection



Definition and Goals

- **Definition/Scope**
  - The Chemical, Biological Detection sub-area is devoted to the development of technology for early detection and warning to provide situational awareness and permit forces to avoid the chemical, biological threat.
- Goals/Rationale for Investment
  - The goal is to provide a real-time capability to detect, identify, map, quantify, track, and disseminate information on the presence of all chemical biological warfare agent threats at sub-symptomatic dosage levels.

Detection

Status

	CB-01	CB-02	CB-03	CB-04	CB-07
Budget	Y	G	G	Y	Y
Schedule	G	G	G	G	G
Technical Performance	G	G	G	G	G

Accomplishments

- Demo new DNA assays; B. Subtilis, B. Anthracis, VEE virus, and F. Tularensis
- Demo a rapid process (weeks instead of months/years) for the development of recombinant antibodies against new target materials
- Demo the ability to produce well characterized and quantified biological aerosol test samples with an “Ink Jet Aerosol Generator”
- Completed mobile laboratory platform for ambient aerosol background data collection/analysis
- Demo Mass Spec’s ability to analyze a complete bacteria cell
- Completed chemical detection LIDAR breadboard for Non-Proliferation Airborne LIDAR Experiment (N-ABLE)
- Accelerated joint pocket-sized chemical agent detector program for transition to EMD
    - Demo breadboards of IMS and SAW technologies
    - Draft formalized standard test/evaluation protocols for technology baseline

Strengths and Weaknesses

- Overall the best managed commodity area
- Program clearly focused on warfighter needs - bio ATD will demonstrate point and early warning capability (DNA probe, aerosol collector system)
- Chem detection now to 11 joint programs
- Sample collection technology clearly requires much more effort
- Mini-ims point chem detector should be accelerated (could replace ACADA, M15-A2)
- Need more emphasis on situational awareness - JWARN program, but need clear MOEs
- Standoff Bio expensive, no forseeable payoff - Lincoln Lab study
- Should continue to look at both SAW and IMS for point applications

- Bio Detection program needs increased connection with industry - DARPA?
- Increase emphasis on DNA/RNA detector work
- Increased emphasis on generic detector technologies (Nerve, MS)
- ESI/MALDI efforts promising, but need to accelerate academia S&T
- Some schedules too lengthly to qualify as S&T programs

Issues

- Statement of Issue
    - Is the Department taking the best approach to solving the remote and point detection problem? Is there a proper balance of investment in Stand-off vice in-situ detection?
- Options and Resource Implications
    - Re-allocation of resources between stand-off and in-situ sensor programs
- Schedule for Resolution
    - JBREWS contains as one of its effort, a study to determine the CONOPS and optimal distribution of stand-off and in-situ detection capabilities.
- Budget withholds impacting program execution
    - represents 19.2% of baseline
    - funds now released
- Stand-off vs. in-situ bio detection
    - Is the Department taking the best approach to solving the remote and point detection problem? Is there a proper balance of investment in Stand-off vice in-situ detection?
    - JBREWS will study CONOPS for viability of S/O vs in-situ capabilities
    - MIT study suggested that UV for standoff would not achieve adequate range
    - UV S&T still has applicability to bio point detection - range (laser power) no longer an issue.

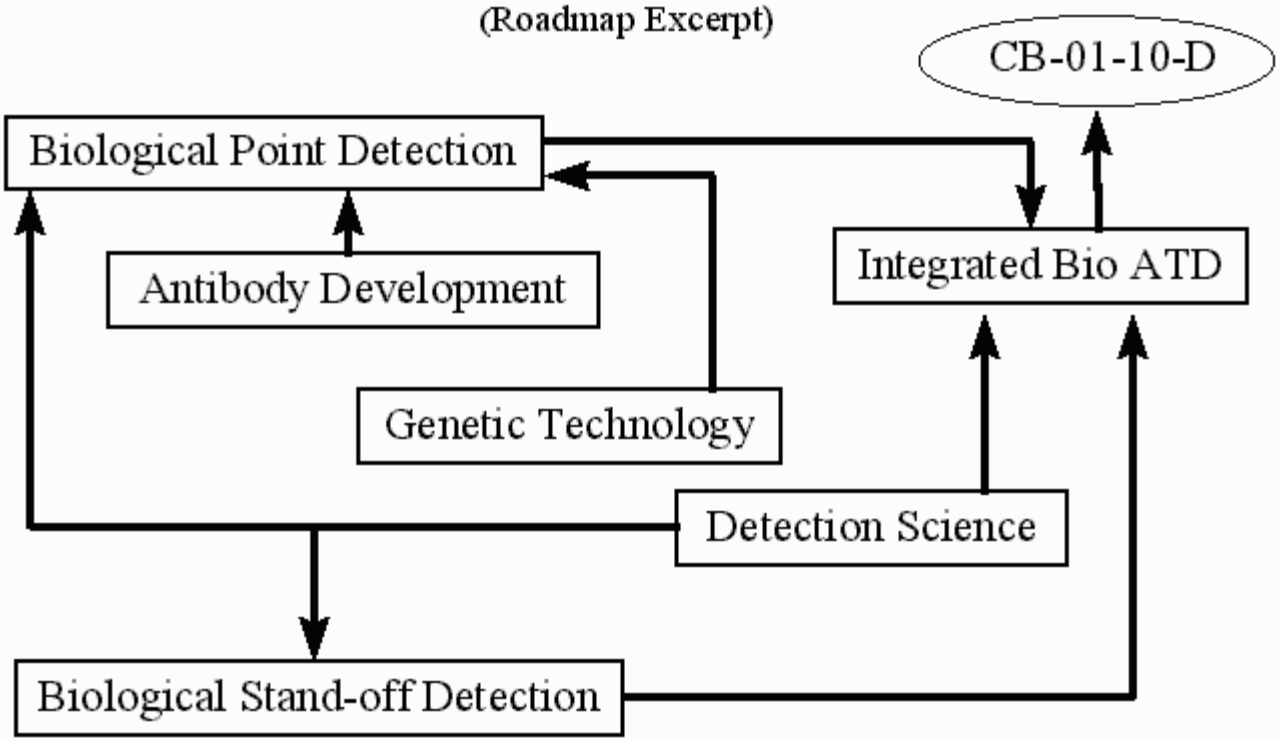
CB-01-10-D
Integrated BioDetection ATD

- By FY97, demonstrate biological point detection of biological agents using technologies such as DNA Probes, electrospray mass spectrometry, planar waveguides, and flow cytometry with more stable reagents and simpler identification chemistry. These technologies will provide a 10 fold enhancement in sensitivity to toxins and add a virus identification capability while providing significantly improved logistics, such as 10 fold increase in response times, trainable algorithms, 5x size/weight reductions, and increased environmental operating range. Also by FY98, demonstrate early warning biological agent detection and identification using technologies such as vibrational circular dichroism, Mueller matrix scattering, and the application of near infrared and ultraviolet laser light scattering. By FY99, products will be demonstrated separately and as an integrated entry in future Battle Lab advanced warfighting experiments. Also by FY98, develop a combinatorial genetic super library for rapid selection of clones which produce high affinity antibodies against any potential biological threat agent. Antibody selection and products would be completed in weeks, rather than a year, at a 90% cost reduction and with far more flexibility than is possible with conventional testing.
- Supports: Joint Service Biological Point Detection System (J-BPDS) and Joint Service Biological Standoff Detector System (J-BSDS).

Detection

CB-01-10-D Integrated BioDetection ATD

(Roadmap Excerpt)



Detection

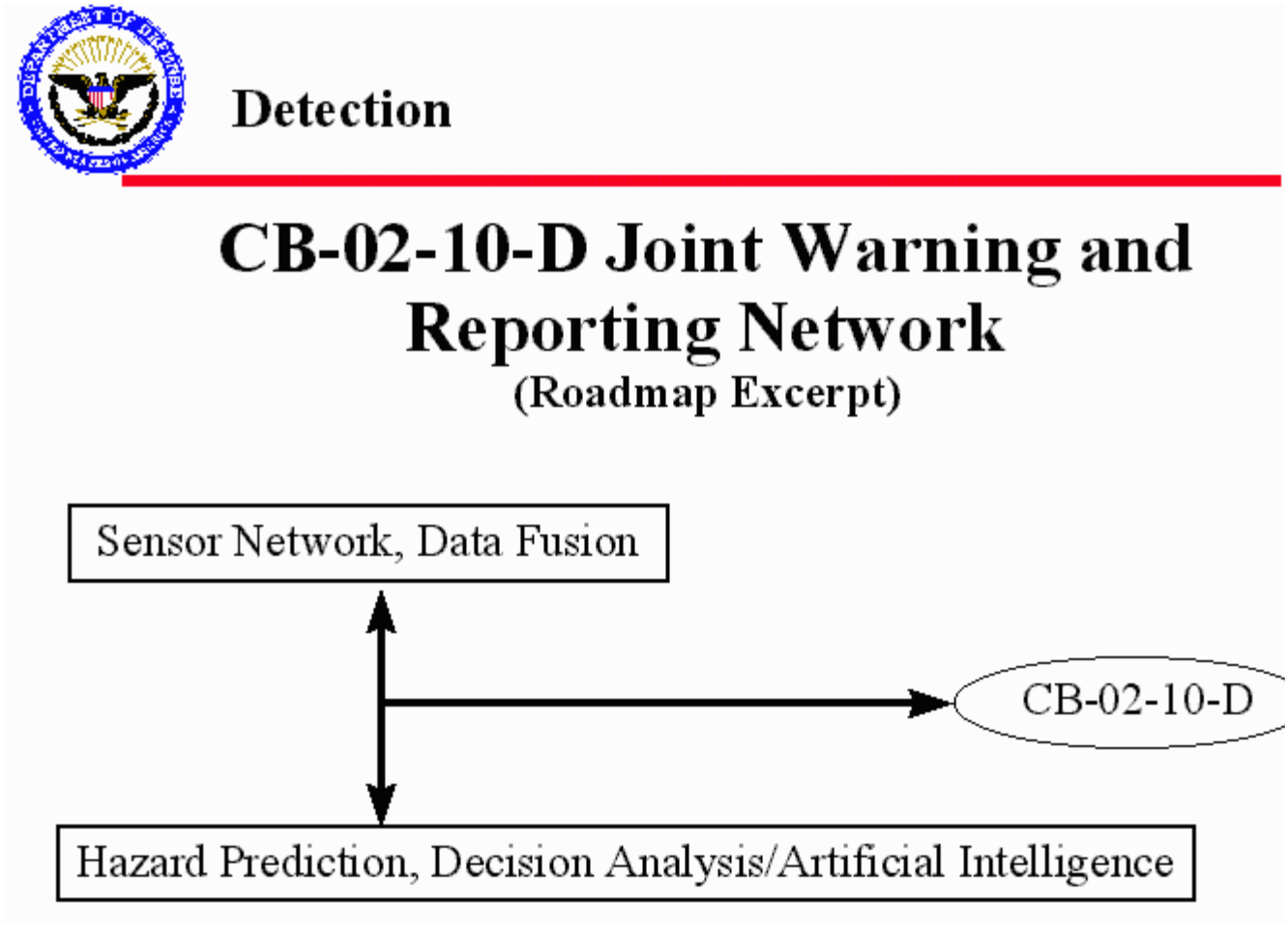
CB-01-10-D Integrated Biodetection ATD Exit Criteria

OPERATIONAL CAPABILITY	CURRENT CAPABILITY	NEAR TERM (FY98)	END ATD GOALS (FY99)
	NDI-BIDS	P3I -BIDS	ADD
Bacteria identification	2-agents(1)	5-agents(2)	All threats
Automated virus ID	None	None	All threats
Identification sensitivity	25 ACPLA	15 ACPLA	1 ACPLA
Selectivity	Antibody-based	Antibody-based	DNA-based
Identification times	30-minutes	20-minutes	20-minutes
Operator interface	Manual	Semi-automatic	Automatic
Logistics burden	Multiple reagents	Multiple reagents	Single-step assays
Reagent storage	Basic	Basic	Hot, basic, cold
	NDI-LRBSDS		BAWS
Detection of missile, bomblet, covert release over corps area	Low probability	Same	High probability
Upwind alert to attacked area	Post-exposure warning	Same	Pre-exposure warning
Aerosol type	Generic(aerosol)	Same	Specific(bioaerosol)
Threat source	Line source	Same	Line, point sources
Platform	Helicopter	Same	Ground unit
Battlefield integration	Voice transmission	Digitized transmission	Digitized transmission

(1) Plus two toxins
(2) Plus three toxins
ACPLA = Agent Containing Particles per Liter of Air
ADD = Automated DNA Diagnostic
BAWS = Biological Aerosol Warning System
BIDS = Biological Integrated Detection System
LRBSDS = Long Range Biological Standoff Detection System
NDI = Non-Developmental Item

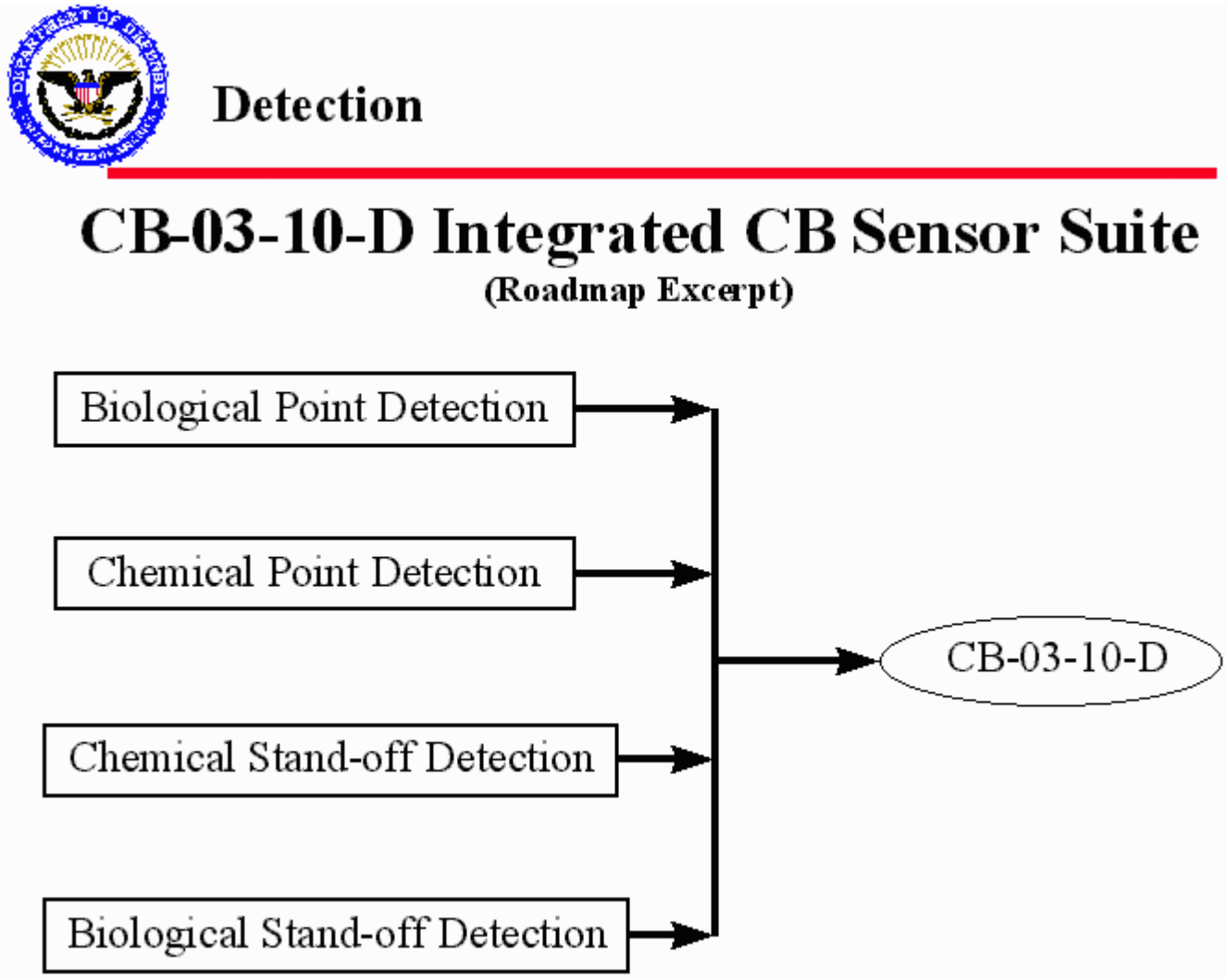
CB-02-10-D JWARN

- By FY00, demonstrate hardware and software to bring sensor information into the C4I system. This will provide commanders the situational awareness on current/projected chemical/biological warfare threats made available from the integration of sensor data to geographical and meteorological data and threat models. The network can be rapidly updated with the latest intelligence data. By FY98, identify, test, and characterize hardware and software required to provide the bridge from the warfare agent sensors to the C4I system. Using FY96 capabilities of MICAD, HAZWARN and VLSTRACK as the baseline, JWARN will have 10 to 100 fold increase in data telemetry (manipulation and transmission) capabilities and a threat model that can display the current status of threat along with a time-projection that is updated continuous with new sensor, geographical, meteorological, and intelligence data. By FY99, integration of hardware and software between the sensors and the C4I system through the use of an artificial intelligence that can statistical correlate and filter all the incoming data.



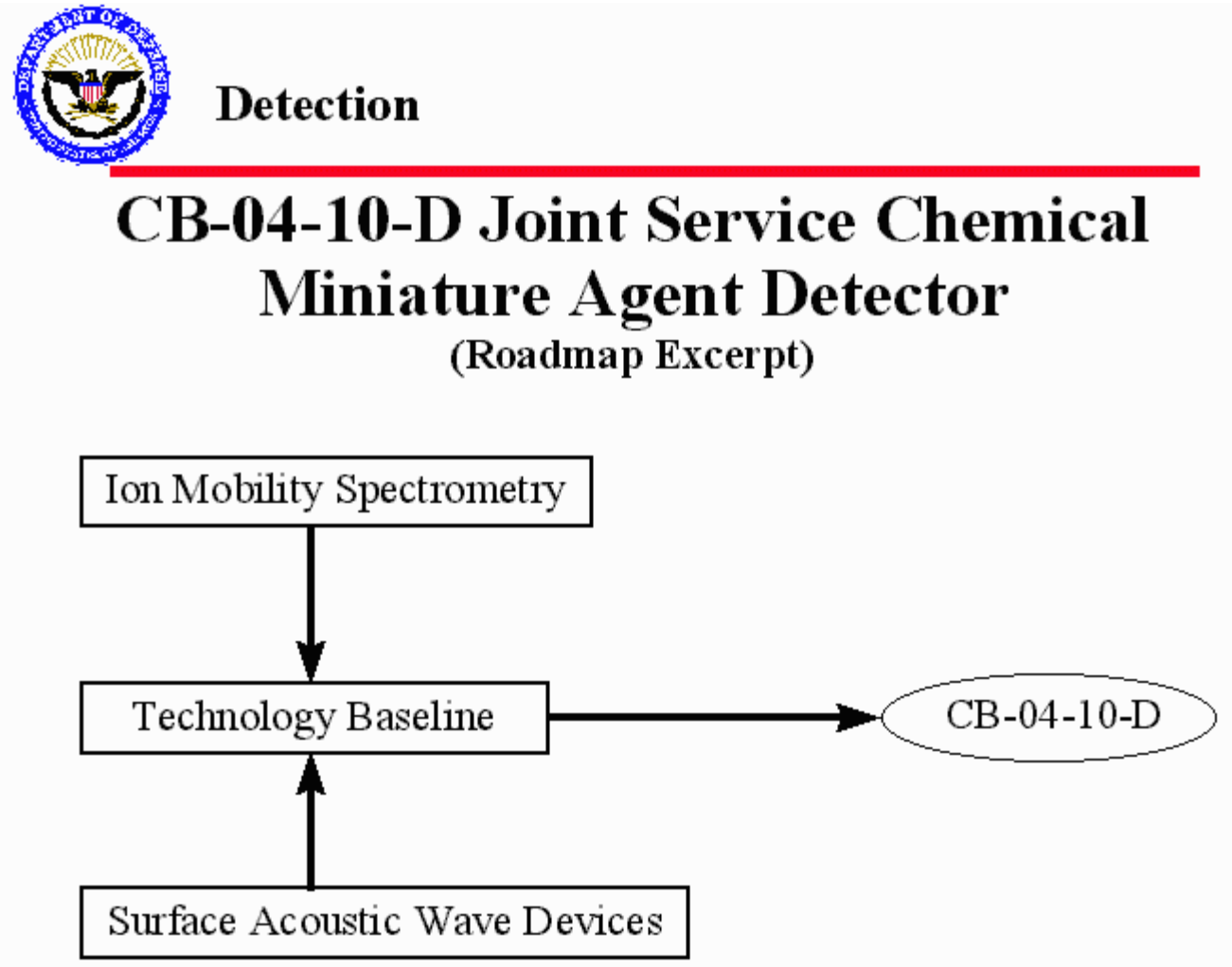
CB-03-10-D
Integrated CB Sensor Suite

By FY97, demonstrate chemical and biological point, and chemical standoff sensor technologies for use in unmanned vehicles (air and ground). This demonstration will identify the sensor technologies that will be used to make up the various sensor suite packages that will be utilized in the unmanned vehicles. The suite configuration will be determined by payload size and power requirements. Each candidate sensor will be configured in modular form to provide for rapid assembly (under 30 minutes) into the appropriate sensor suite configuration depending on the need and vehicle platform. By FY98, test and characterize capabilities of sensor systems on unmanned vehicles. A database of sensor module capabilities and characteristics will provide the user the optimal sensor suite configuration to meet his needs balanced against the unmanned platform capabilities. By FY99, delivery of a completed sensor suite package. Demonstrate the range of sensor configurations in the unmanned vehicles. By FY00, addition of bio standoff capabilities to the sensor suite package.



CB-04-10-D
Joint Service Chemical Miniature Agent Detector (JSCMAD)

- By FY98, demonstrate breadboards for a pocket sized chemical agent detector based on technologies such as ion mobility spectrometry or surface acoustic wave sensors. By FY99, complete design for a small lightweight personal detector and begin building a brassboard. By FY00, deliver completed brassboard for testing and characterization. The small lightweight personal safety monitor will be capable of detection at less than incapacitating levels for nerve, blister, and choking agents, usable for 72 hour operations, less than 2 lb. in weight, fit inside battledress pockets, and archival capabilities. By FY01, transition to 6.5 engineering manufacturing development (EMD) finalized brassboard system. This effort will provide for a range of Joint Service applications including early chemical detection and warning for personal safety, monitors for low level contamination of interiors of aircraft, ships, ground vehicles, and facilities and contaminated water, and as deployable remote sensors.

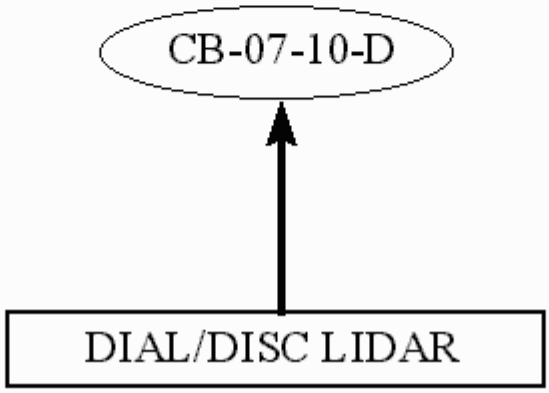


CB-07-10-D
Laser Standoff Chemical Detection Technology

- By FY99, reduce the size of the Joint Service Chemical Warning and Identification LIDAR Detector (JSCWILD) to a 2 cubic ft (40% reduction) hardened package. By FY03, demonstrate a JSCWILD brassboard with sufficient laser power and detector sensitivity to detect chemical agents at a distance of 20 km (400% increase from FY96 baseline). By FY04, demonstrate a brassboard with a wide band frequency agile laser in a compact package that can scan using multiple frequencies that is capable of detecting both chemical and biological agent. By FY07, reduce the size and weight of the integrated chemical biological LIDAR system by 60% in comparison to the current state of the art in FY97.
- Supports: Joint Service Chemical Warning & Identification LIDAR Detector (JSWILD), Joint Service NBC Reconnaissance System (JSNBCRS), and Airbase and Shipboard Chemical and Biological Defense

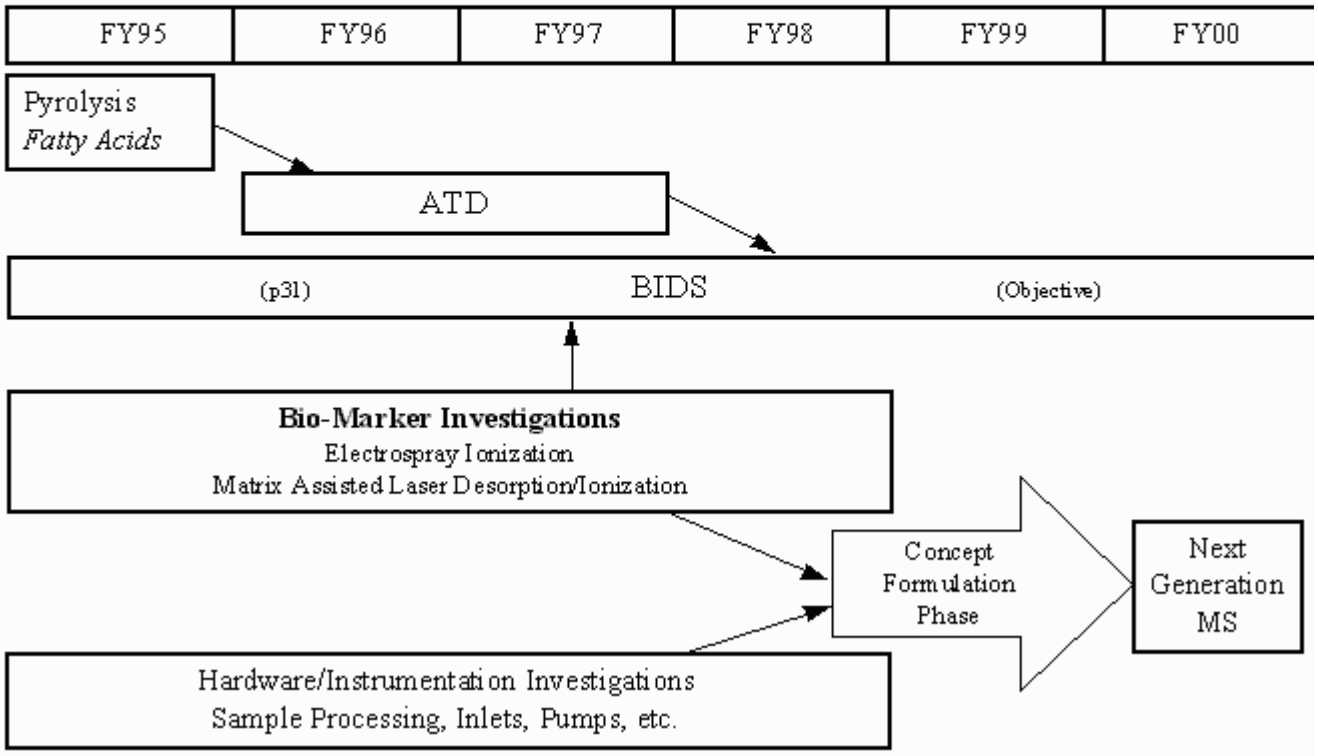
CB-07-10-D Laser Standoff Chemical Detection Technology

(Roadmap Excerpt)



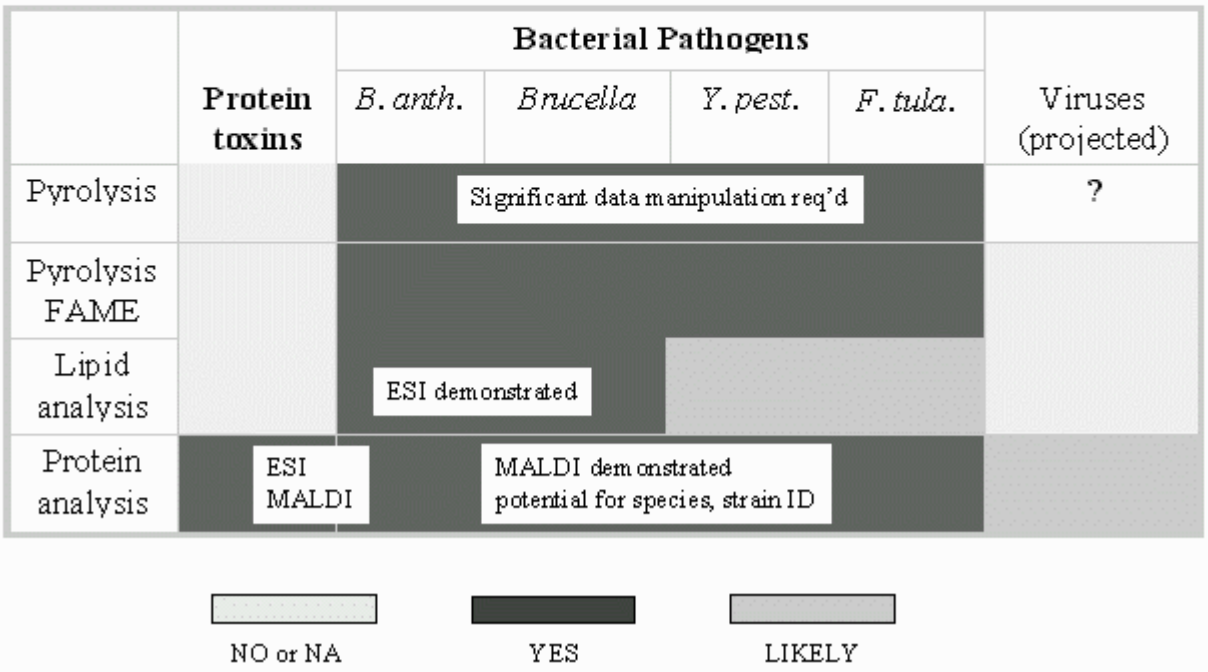
Detection

Integrated Bio MS Plan



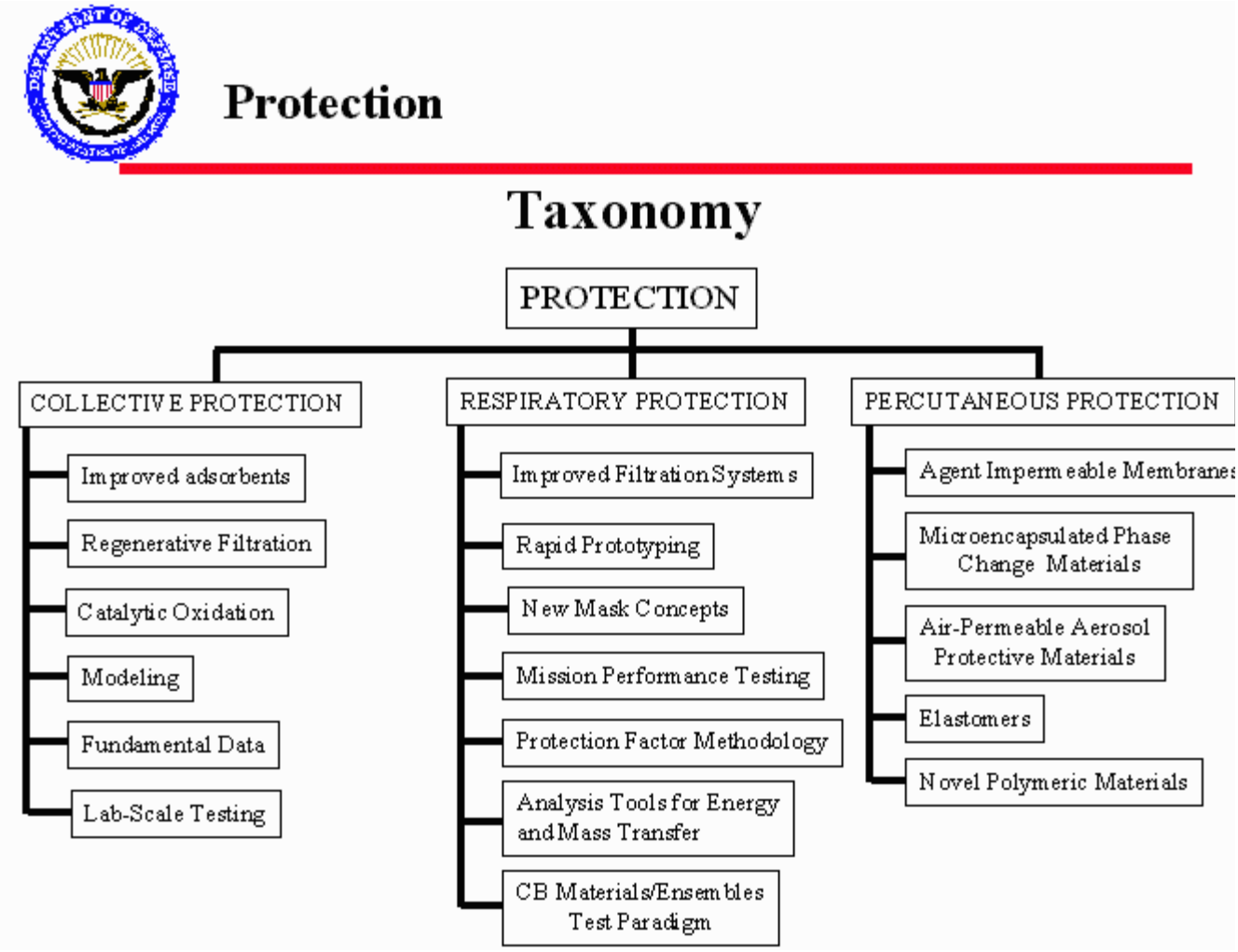
Detection

Biological Mass Spectrometry
Identification Capability Based on Available Data



Protection

- Dr. Eugene Wilusz
- U.S. Army Soldier Systems Command
- U.S. Army Natick RD&E Center



Definition, Scope, and Goals

Definition:

- Individual (Percutaneous and Respiratory)
- Collective

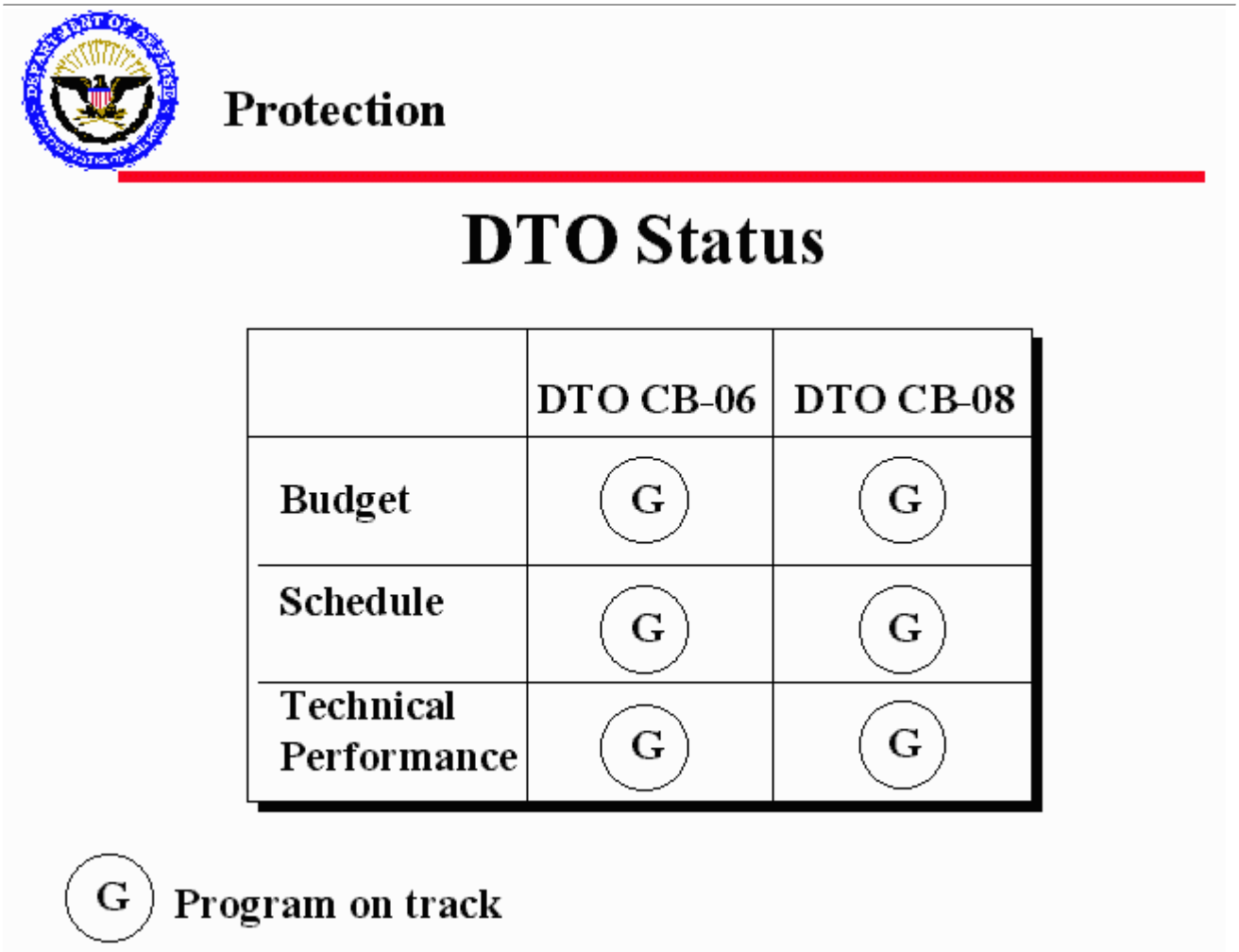
Scope:

- Clothing Ensembles
- Respirators
- Filtration Systems
- CB Shelters

Goals/Rationale for Investment:

- Lighter weight, less cumbersome, more efficient clothing and respirators
- Reduced logistics burden
- Integrated protection

- Improved filtration systems
- Affordable tentage and shelters



Accomplishments

- Completed evaluation of physical and barrier properties of leading candidate selectively permeable membrane material. (NRDEC/ERDEC)
- Accomplished limited field test of prototype garments made from candidate membrane.
- Completed a test plan for Joint Army/Navy study to develop a respirator encumbrance model.
- Provided technical support on a Cost and Operational Effectiveness Analysis (COEA) on advanced collective protection systems applicable to shipboard NBC protection.
- Iniated evaluating super-activated carbonaceous adsorbants that have potential application to CB protective clothing and filters.

Strengths and Weaknesses

Funding

Technical/Programmatic

- Need to survey service needs on collective protection.
- No activity to develop residual life indicates-ignoring last years S&T Defense Guidance.
- Except for some Army collective protection, no schedule drivers.
- Need more industry involvement // less trying to duplicate industry capabilities.

Management

- Little top-down structure to collective protection area.
- Individual protection is well structured.

After

- For call pro - little highlighting of progress.

Issues

Statement of Issue:

Inadequate funding to pursue novel approaches to protection problems

Options and Resource Implications:

Stretch program schedules
Pursue low-risk approaches

Schedule for Resolution:

Unknown

Protection

DTO CB-06-12-D Advanced Lightweight Chemical Protection.

▪ By end of FY96, demonstrate the technical feasibility of eliminating/ reducing carbon in the chemical protective ensemble through the use of advanced semipermeable membrane technology. The resulting advanced material system will be 20% lighter in weight than the standard FY96 Battle Dress Overgarment material system, allow selective permeation of moisture while preventing passage of common vesicant agent, provide protection against penetration by toxic agents in aerosolized forms, and provide at least the current level of protection against other toxic vapors and liquids. By the end of FY98, demonstrate via Dismounted Battlespace Battle Lab (DBBL) warfighting experiment and JSLIST II, the efficacy and durability of novel, lightweight chemical protective garments and clothing systems utilizing these agent impermeable membranes.

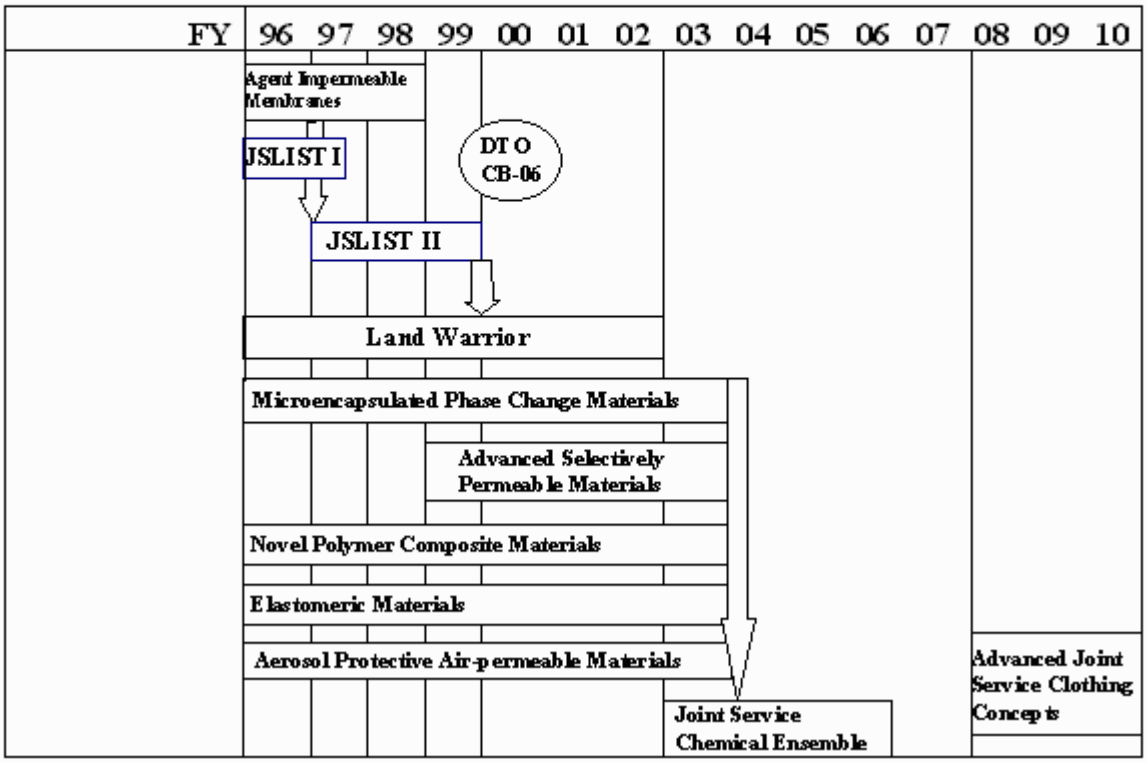
▪ By FY98, develop and conduct physiological testing of a series of microencapsulated phase change materials (Micro-PCMs). By FY99, conduct evaluations of Micro-PCMs for use under chemical warfare overgarments for microclimate cooling and, with a different formulations, for microclimate heating. By FY01, Micro-PCMs will be bonded to selected garments for field evaluation.

Supports: 21st Century Land Warrior, Air Warrior, Crew Warrior, Joint Service Lightweight Integrated Suit Technology II (JSLIST II), Advanced Development--Clothing and Equipment; Engineering Development--Clothing and Equipment.

Lab/Ctr POC:	Service/Agency POC:	USD(A&T) POC:	Customer POC:
Dr. Eugene Wilusz	Mr. Bill Brower	Dr. Sal Bosco	LTC Paul Short
NRDEC	SARD-TT	ODATSD(CBM)	JSIG
(508) 233-5486	(703) 697-8432	(703) 602-5620	(205) 848-4070
	Mr. Joe Brumfield		MAJ John Ensor
	NSWC		DBBL
	(540) 653-8414		(706) 545-5988

Protection

Road Map



Protection

CB-08-12-D Advanced Agent Filtration

Develop and demonstrate, using enhanced adsorbent and aerosol filtration technology, a light-weight, low-profile, low-resistance filter for future joint service respirator systems (i.e., RESPO 21 mask). In FY98, demonstrate form, fit, and function of a candidate filter design for incorporation into advanced mask prototypes capable of meeting C2 canister agent vapor and aerosol filtration requirements. In FY99, demonstrate a mask filter prototype capable of providing full-threat NBC protection wile offering a 50% reduction in airflow resistance and a 33% reduction in overall size. By FY02, demonstrate a non-carbon based chemical warfare agent vapor filtration system suitable for military collective and individual protection applications such as hospital shelters, ships, aircraft, armored vehicles, chemical warfare agent incinerator pollution abatement filters, and individual respirators. A non-carbon vapor filter element will eliminate any possibility of filter fire caused by upsets to other components of the environmental control sub-system while retaining or improving the present chemical warfare agent protection properties of ASZM-T carbon. Several potential system concepts will be developed based on screening of candidate adsorbent materials, engineering design model development and trade studies. By FY04, demonstrate a total or partial replacement of the current adsorbent, ASZM-T carbon, using a modified collective protection filter integrated with an application such as armored vehicle or shelter.

Lab/Ctr POC:	Service/Agency POC:	USD(A&T) POC:	Customer POC:
Dr. Wade Kuhlmann	Denise Pobedinsky	Dr. Sal Bosco	LTC Paul Short
Dr. David Tevault	SARD	ODATSD(CBM)	JSIG
ERDEC	(703) 614-7298	(703) 602-5620	205) 848-4070
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			JSMG
			PM Chemical Demilitarization
			(410) 671-4364

DTO CB-08
Technology Development Plan

Approach

- Evaluate Existing and Candidate Filtration Media
- Select Most Promising Candidates
- Explore Integration Concepts
- Optimize Design and Performance
- Continue Technology Insertion

Accomplishments

- Established Tech Base Projects in:
- Engineered Adsorbents
- Filter Sorbent Structure
- Enhanced Aerosol Filtration

R&D Leverage

- Leveraging Industry, National Labs, Universities, OGA’s, and International Sources

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